State & Private Forestry

Forest Health Protection

South Sierra Shared Service Area

FHP Report: SS10-07

File No. 3402
October 4th, 2010

To: S. Skalski, Forest Supervisor, Stanislaus National Forest,
A.Denton, Mi Wok District Ranger, Stanislaus National Forest

From: State and Private Forestry, Forest Health Protection, South Sierra Shared Service Area.

Subject: Two mile Ecological Restoration Project. Stand Looney 14.

On 17th September 2010, Beverly M. Bulaon and Martin MacKenzie (Forest Health Protection, South Sierra Shared Service Area) accompanied by Marty Gmelin (Project Action Leader, Mi Wok Ranger District), conducted a second field evaluation to Stand Looney 14, part of the Two Mile Ecological Restroation Project.

Most of the stand Looney 14 was managed previously, except for one steep section with many small tree diameters and an absence of stumps which presumes this section has probably never been logged. There is no plan to do work in this portion of the stand. Site conditions suggest railway logging of pines and salvage logging of beetle-killed trees occurred. Based upon widespread infection observed, borate prevention measures to reduce incidence of Annosum root disease in past salvage operations was either poorly applied or not deployed at all.

This stand is dominated by two fungi: one native and one exotic. The native fungus is *Heteobasidion occidentale* and the exotic fungus is *Cronartium ribicola*. The native fungus *H. occidentale* is the cause of Heteobasidion root disease of true firs (*Abies sp.*) and the exotic *C. ribicola* is the fungus that causes white pine blister rust of five needled pines – in this stand, sugar pines (*Pinus lambertiana*). Any restoration plans proposed for this site must recognize these fungi while still cognizant of the risk of attack by native bark beetles.

South Sierra Shared Service Area
Based on the Stanislaus National Forest
19777 Greenley Road
Sonora, California 95370

Forest pathologists agree that Heterobasidium root disease has two forms: one infecting pines (P type), the other infecting true firs (S type). Because P and S types are unable to cross breed, they are known as intersterility groups (ISG's). By using a combination of genetic, morphological and ecological methods Otrosina and Garbellotto (2009) raised the ISG's to the level of separate species. While the web citation to their paper is given below, for the rest of this report the disease of fir this fungus causes will simply be referred to as Heterobasidion root disease

http://169.229.201.201/garbelotto/downloads/OtrosinaGarbelotto2009.pdf

Bark beetle threat.

Figure 1. *A white fir being attacked by the fir engraver beetle.*

Fir engraver *Scolytus ventralis* is the primary bark beetle attacking true firs and as long as there are firs in the stand there is always some risk of beetle attack. However the probability of a successful attack and the extent of that attack is dependent upon many factors, some of which we can control. Fir engraver is an opportunistic beetle that particularly targets trees already weakened by other damage agents. Given the levels of Heterobasidion root disease observed, beetle attacked trees were probably initially stressed by the root disease fungus. Fir engraver is not considered as aggressive as some other bark beetle species (e.g. mountain pine or western pine beetles), and may only target portions of trees at a time. Top kill is often associated with fir engraver activity (figure 1), but mass attack will occur when trees are severely stressed. It is expected that future beetle mortality may approach 1 or 2 trees per acre per year, at endemic levels. The restoration activities planned for this stand should keep the overall stand basal area below the threshold that might initiate a bark beetle outbreak.

White Pine Blister Rust.

Figure 2. *White pine blister rust flagging observed in a large overstory tree.*

Within the stand, over 90% of the large sugar pine trees observed had some degree of white pine blister rust infection (Figure 2). Although it is difficult to predict when trees will succumb in the next 30 to 40 years, research has found that mortality is probable. Severe infection levels in many of the poles and saplings in the under story suggest that the greatest level of mortality in the next decade will be in the regeneration, rather than in the overstory (see figure 3). Older trees appear to die more slowly, but this can be a size factor, rather than genetic resistance. Therefore, to retain sugar pine in the stand it is essential to begin the restoration now, and not delay another 20-30 years.

Webbing and frass found on a small pine (figure 3) was probably produced by a species of pine sawfly in the Genus *Acantholyda*. There are about 20 species of this insect in the West and there are reports of this insect having attacked white pine seed orchards in Canada. Most of the entomology literature on this genus involves of the exotic, *Acantholyda erythrocephala* attacking *Pinus strobus*, in the East. FHP will continue to monitor this insect if damage becomes more evident.

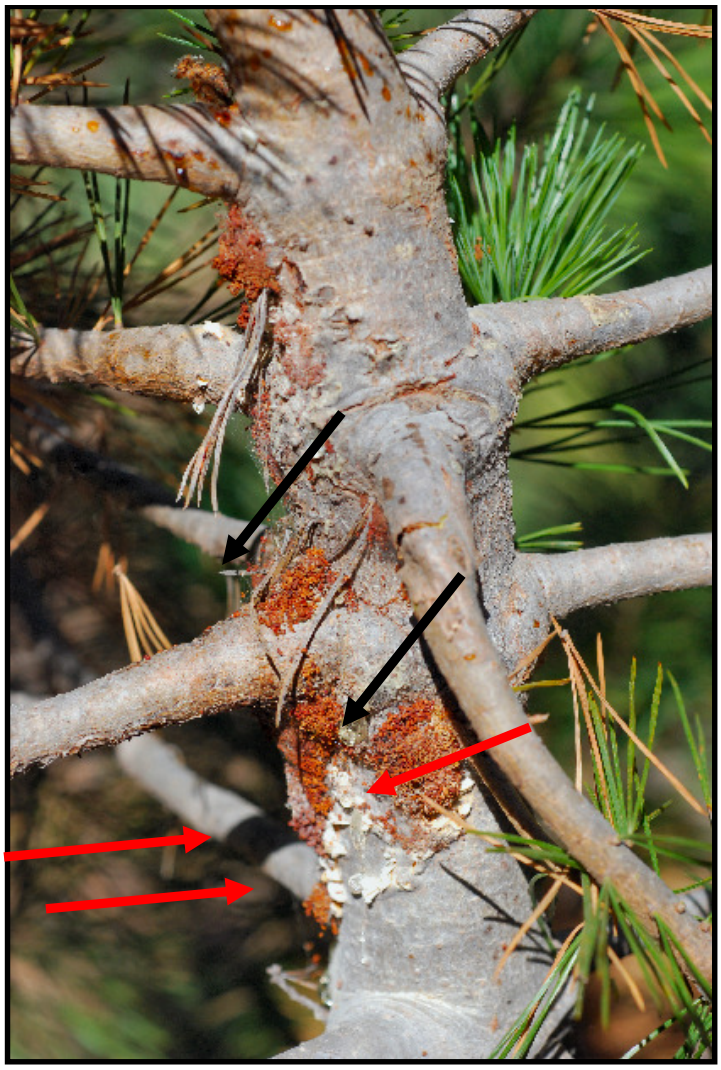

Figure 3. *Aecial stage of WPBR (red arrows) on a Sugar pine sapling, and putative false webworm frass (black arrows).*

Although a few *Ribes* plants in this stand were checked, the alternate host did not appear to be rust infected at this time of the year.

Native fungus causing Heterobasidion Root Disease, *Heterobasidion occidentale*.

There are two major factors that contributed to the widespread *Heterobasidion* (aka *Annosus*) incidence throughout the west side of the Sierra Nevada. First, historic selective removal of pines has resulted in an increase of shade tolerant true firs, thus host material is more available for the fungus. Secondly, after salvage logging of beetle-killed firs, prophylactic treatments on freshly cut fir stump surfaces to prevent the buildup of fungal inoculum were not rigorously applied.

In natural settings, *H. occidentale* is an effective killer of fir trees but not efficient at finding new hosts. Fir trees have a great propensity to become root-grafted to each other and thus in a maturing stand the trees by virtue of their root grafts are in effect "holding hands (by roots) underground". Thus if the

poorly competitive *H. occidentale* fungus is living in one tree's root system, it travels to nearby trees by growing through root systems root grafts. The disease is very difficult to spot amongst a healthy carpet of fir seedlings that cover root disease centers. Until seedlings become interconnected, the disease has limited ability to become established. By growing within communal root systems, this poorly competitive fungus avoids competition outcompetes other fungi and microorganisms.

Prophylactic applications of borates only work if applied to stumps within the first few hours of the stumps being cut. Because the spores of *H. occidentale* are so poorly competitive, borate applications only need to work in the first few hours after a stump is cut. Stumps begin to dry out and become rapidly colonized by other microorganisms, therefore, non-competitive *H. occidentale* spores have difficultly becoming established. *Heterobasidion* compensates for the non-competitive nature of its spores germination by producing an astronomic numbers of spores over a long period of time. In this stand, the occasional older cut stump bore fresh (spore producing) conks of the fungus. Close examination revealed a ring or partial ring of callus between bark and rotted wood. These stumps live because they were grafted to the root systems of adjacent (living) trees. The internal fungal conks were fresh because they had access via root grafts to heart and inner sapwood of adjacent living trees. After the bulk of the original stump had been decayed the conk, fed by the adjacent trees, continues producing large numbers of spores.

The No-action option

The no action option is best viewed from three perspectives: first, the primary beetle; secondly, the two major fungi in this stand. As indicated earlier, fir engraver is an opportunistic beetle that targets stressed trees, initially by causing top kill and eventually mortality.

Healthy carpets of fir seedlings cover root rot pockets making it difficult to detect the disease. Seedlings are not yet root grafted, so the disease has not yet become established in root systems. This carpet of healthy fir trees will remain healthy until the trees have matured, and canopy closure begins to incite stress. Bark beetles may begin thinning a few of them. If salvage treatments were implemented, stumps need to be immediately treated after harvest. Present spore producing conks will infect this next rotation and the fungal outbreak will continue. Heterobasidium is successful because it can persist long periods, continually producing spores the entire time. *Heterobasidion* fungus is a native fungus that has co-evolved with the fir trees, thus it will never kill all of its hosts. If no action is taken, this disease will perpetuate itself at the high level currently existing in the stand. These levels are a consequence of past management actions, but would not be expected in a naturally diverse stand.

In contrast, the exotic rust fungus (WPBR) has not yet coevolved with its current host. In the short term, the majority of sugar pine monarchs (figure 4) will succumb to the disease as hosts have yet to develop genetic resistance. A significant number of the replacement sugar pines in the understory are rust infected, and will succumb even faster than overstory trees. A few percent – possibly 2-5%, of sugar pine seeds may contain genes for resistance to blister rust. Under the no-action scenario, the probability any of these seeds to survive on a site fully occupied by fir regeneration and not become rust infected is very low.

With no-action management, the native fungus, native insects, and white firs will continue to co-exist at high levels; sugar pine has a high probability of being extirpated from this site. The genetic pool of sugar pine has very low levels of resistance genes. Therefore, the possibility of becoming extinct in

particular areas of the landscape is feasible. There is a chance that white pine blister rust will do to the sugar pine what Dutch elm disease did to the American elm.

Prevention is a long-term benefit

One solution for disease control is to break up the underground landscape. This can be achieved by introducing diversity by establishing more pines or incense cedars between fir trees. Non-hosts will break up integrated fir root systems below ground, denying the disease pathways to create new infections. This strategy will not eliminate the disease from the stand, but reduce injury to sustainable levels. Current levels of mortality are considered unacceptable as it contributes to fuel loading and increases risk of catastrophic wildfire.

FHP does not advocate using prophylactic prevention treatments for this project. The fungus is already entrenched in the root systems of existing firs on site that costs may not exceed the benefit. The focus at inital entry is to restore biodiversity into the stand by providing opportunities to re-establish sugar pines. Given the current level of Heterobasidion root disease, it is inevitable that over the next 30 years a few firs will die along the perimeter of restored pockets. These deaths will reduce resource competition and increase survival of pines. However, once sugar pines have been restored, protecting remaining fir is the next priority. The next entry in 20 to 30 years, borate prevention measures should be implemented.

Figure 4. *Sugar Pine Monarchs photographed at the edge of the stand. FHP will monitor these trees for mortality as this project proceeds.*

Conclusion

FHP is fully supportive of this project, conferring with sound Forest Health principles. However, legacy sugar pine will continue to be lost due to white pine blister rust (see Figure 4). Therefore, it is critical to consider vegetation management that improves and restores sugar pines in this stand.

Please contact us with any additional questions or concerns.

/s/ Beverly Bulaon
Entomologist
Forest Health Protection
(209) 532-3671 x323
bbulaon@fs.fed.us

/s/ Martin MacKenzie
Plant Pathologist
Forest Health Protection
(209) 532-3671 x242
mmackenzie@fs.fed.us

CC: Julie Lydick
Sheri Smith
Phil Cannon
Dave Bakke
Christina Welch
John Schmechel
Deb Romberger

References

Otrosina, W. and M. Garballeto 2009. *Heterobasidion occidentale sp. nov.* and *Heterobasidion irregulare nom. nov.:* A disposition of North American Heterobasidion biological species. Mycological Research, pgs 1-10.